

Kinetics Problems

①



2 b Cl b/c it is used in step 1 and Regenerated in Step 2
so it is present at the beginning + end of Rxn

3 c ClO is formed in step 1 and then reacts in step 11

d i 2nd

$$\text{ii } \frac{\text{M}}{\text{s}} = \frac{\text{M}}{\text{s}} \text{ M} \quad \boxed{\text{units} = \text{s}^{-1} \text{M}^{-1}}$$

iii Step 1 is the rate determining Step b/c the Cl + O₃ which are in the rate law are in step 1 of the Rxn.

$$2 \text{ a } \frac{\text{Rate}_2}{\text{Rate}_1} = \frac{k [\text{ClO}_2]^x [\text{O}_3]^y}{k [\text{ClO}_2]^x [\text{F}_2]^y} \rightarrow \frac{\text{Rate}_2}{\text{Rate}_1} = \frac{[\text{F}_2]^y}{[\text{F}_2]^1} \Rightarrow \frac{9.6 \times 10^{-3}}{2.4 \times 10^{-3}} = \frac{(0.4)^y}{(0.1)^1} \quad y = 4^y \quad y = 1$$

$$\frac{\text{Rate}_3}{\text{Rate}_1} = \frac{k [\text{ClO}_2]^x [\text{F}_2]^1}{k [\text{ClO}_2]^x [\text{F}_2]^1} \Rightarrow \frac{9.6 \times 10^{-3}}{2.4 \times 10^{-3}} = \frac{(0.02)^x (0.2)^1}{(0.01)^x (0.1)^1} \quad 4 = (2)^x (2) \quad 2 = 2^y \quad y = 1$$

$$\boxed{\text{Rate} = k [\text{ClO}_2] [\text{F}_2]}$$

$$b \quad 9.6 \times 10^{-3} \frac{\text{M}}{\text{s}} = k (0.020 \text{ M}) (0.20 \text{ M})$$

$$\boxed{k = 2.4 \frac{1}{\text{Ms}}}$$

c.

$$9.6 \times 10^{-3} \frac{\text{M ClO}_2\text{F}}{\text{s}} \times \frac{1 \text{ mol F}_2}{2 \text{ mol ClO}_2\text{F}} = 4.8 \times 10^{-3} \frac{\text{M F}_2}{\text{s}} \text{ is the rate of F}_2 \text{ disappearance}$$

d. ~~Step 1~~ ~~Rate 1~~

Mechanism 1

~~Rate = k_2 [ClO_2F_2]~~ $\text{Rate}_{\text{exp}} = k_2 [\text{ClO}_2\text{F}_2]$

~~Rate = k_1 [\text{ClO}_2\text{F}_2]~~

$\text{Rate}_{\text{eq}} = k_1 [\text{ClO}_2][\text{F}_2]$

$\text{Rate}_{-1} = k_{-1} [\text{ClO}_2\text{F}_2]$

$k_1 [\text{ClO}_2][\text{F}_2] = k_{-1} [\text{ClO}_2\text{F}_2]$

$[\text{ClO}_2\text{F}_2] = \frac{k_1}{k_{-1}} [\text{ClO}_2][\text{F}_2]$

sub

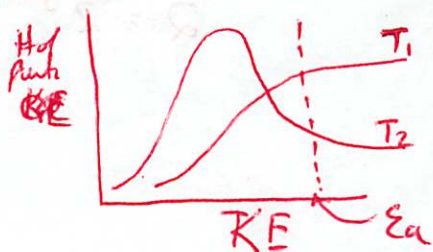
$$\text{Rate} = \frac{k_2 k_1}{k_{-1}} [\text{ClO}_2][\text{F}_2]$$

$$\text{Rate} = k [\text{ClO}_2][\text{F}_2]$$

Mechanism 2 does not match the Rate expression.

3 a The orientations must be in the correct orientation and high enough E to overcome the activation of the Reaction.

b lower Temp would decrease the Rxn rate b/c less particles would be moving at w/ the KE above the E_a



$T_1 > T_2$

C $\text{Rate}_2 = k_2 [\text{AB}][\text{B}]$

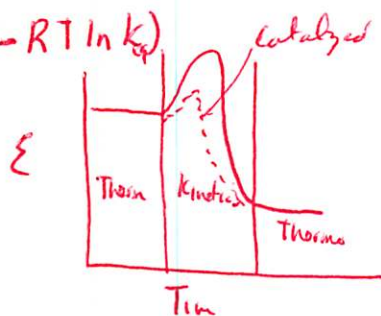
$\text{Rate}_2 = k_1 [\text{A}][\text{B}] = k_1 [\text{AB}]$ Sub

$[\text{AB}] = \frac{k_1}{k_1} [\text{A}][\text{B}]$

$\text{Rate}_2 = \frac{k_2 k_1}{k_1} = [\text{A}][\text{B}][\text{B}]$

$\boxed{\text{Rate} = K [\text{A}][\text{B}]^2}$

d A catalyst increases the Rate of Rxn, but does not change the Free Energy of the Rxn or the ΔH , or ΔS . Since the K_{eq} is dependant on ΔG ($\Delta G = -RT \ln K_{eq}$) by lowering E_a So the Eq constant is temp dependant and is not affected by Activation E .



4. a Using the Arrhenius Eqn $\ln K = \frac{-E_a}{R} \left(\frac{1}{T} \right) + \ln A$
 which is a linear Eqn $y = m x + b$

If you graph the $\ln K$ vs. the $\frac{1}{T}$ for each value in the given Table the Activation E will be the slope of the line multiplied by $-R$ (universal gas const).

b To determine if the Rate is first order graph $\ln [P_A]_t = -k t + \ln (P_A)_0$
 where $y = m x + b$

If this graph is a straight line w/ (-) slope the Rxn is first order and the Rate constant is the (slope $\times -1$).

To determine if the Rxn is 2nd order graph $\frac{1}{[P_A]_t} = k t + \frac{1}{[P_A]_0}$ where $y = m x + b$

If this graph is a straight line w/ + slope the Rxn is 2nd order and the slope is the Rate constant.